High order harmonic radiation from laser plasmas

R Stefanuik, B Ramakrishna, F O'Reilly, E Sokell & P Dunne.
(School of Physics, University College Dublin, Belfield, Ireland)

Introduction

• High-order harmonic generation (HHG) is a promising technique for obtaining new sources of coherent radiation which has the potential to become a future XUV source [1].

• A nanosecond laser with focused intensities of the order of 10^{11} W/cm^2 is used to produce a plasma. A 30 fs terawatt pulse with focused intensities up to 10^{18} W/cm^2 interacts with the target plasma to produce HHG emission.

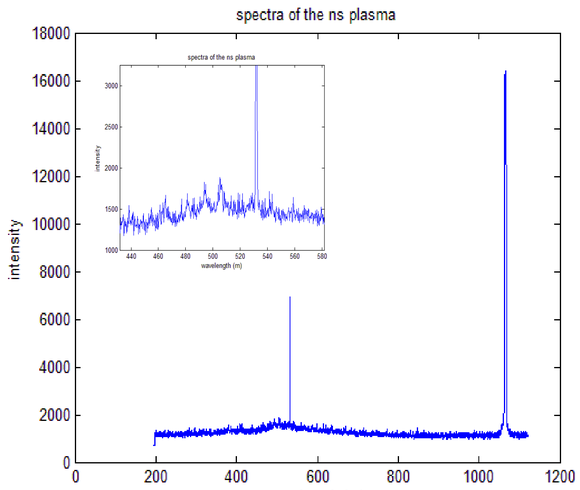

Figure 3: *The spectrum of a plasma formed on a planar Si target by the Nd:YAG laser.*

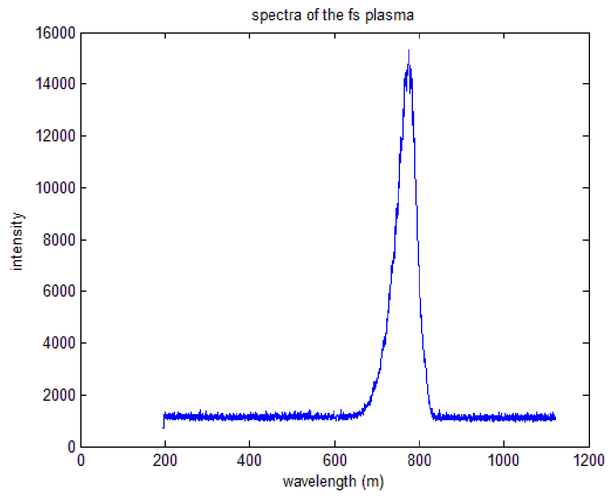

Figure 4: *The spectrum of a plasma formed on a planar Si target by the Ti:Sapphire laser.*

Experimental set up

The chamber set up is given in Fig 1. A Nd:YAG laser with a pulse duration of 7 ns delivers 220 mJ onto the target. The fs laser is a Ti:Sapphire laser, which has an energy of between 30 and 35 mJ in 30 fs. Fig 2 shows the timing between the ns pulse and the fs pulse.

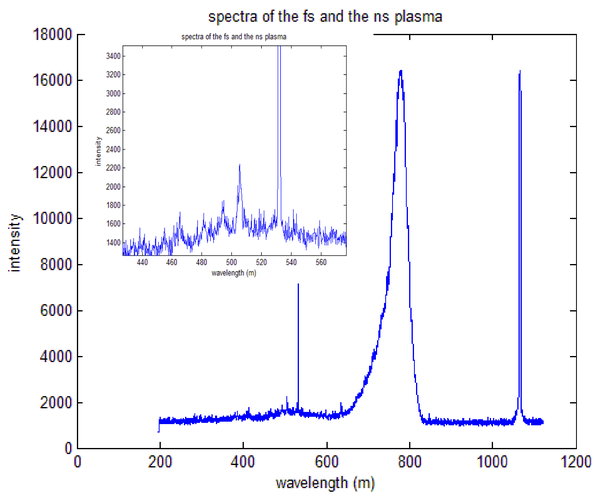

Figure 5: *The spectrum of a plasma formed on a planar Si target by the Nd:YAG & Ti:Sapphire lasers.*

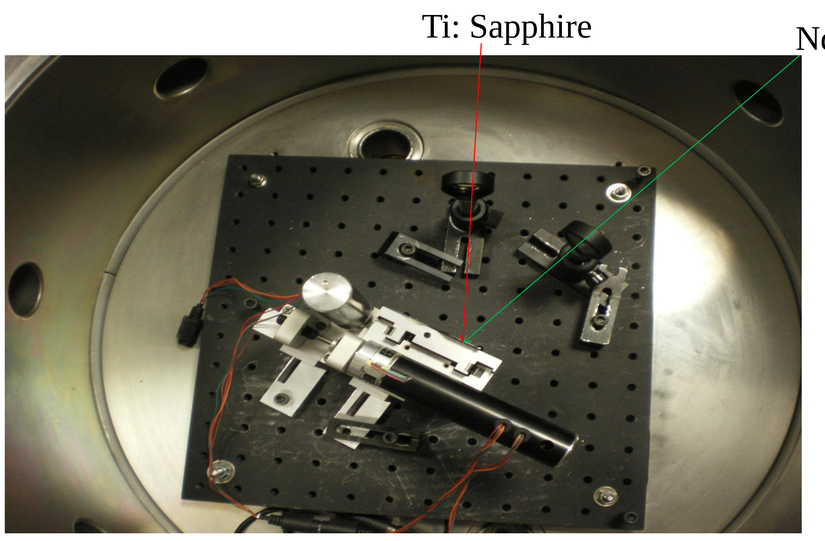

Figure 1: *The interior of the vacuum chamber.*

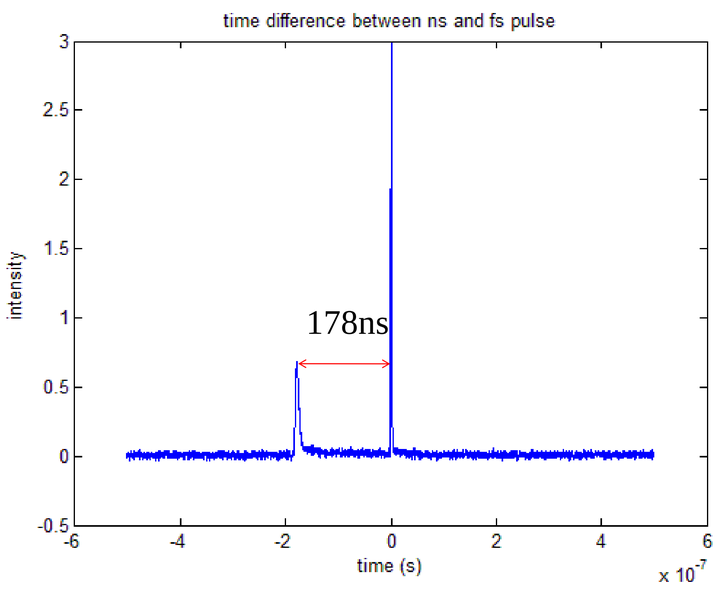

Figure 2: *Time separation between the fs and the ns pulses.*

Initial results

• We have taken emission spectra of Si. Fig 3, Fig 4 and Fig 5 show the spectra obtained from our first experimental runs.

• In Fig 3 we see the emission spectrum of the plasma produced by the ns pulse. There are a number of other weak emission lines present including 634.4 nm, 505.3 nm, 504 nm, 413 nm and 385 nm. All of these lines are known to be emitted by the Si$^+$ ion.

• In Fig 4 we see the Ti:Saphire 780 nm reflection from the target, with no apparent emission from the Si target.

• Fig 5 shows the emission when 2 lasers fire at the same position of the target. It can be seen that all of the transitions present in Fig 3 are still present in Fig 5, although their amplitude is boosted by the addition of the fs laser. We see that there are no different transitions present, even at 260 nm, the wavelength of the 3rd harmonic.

Future plans

• We will vary the time lag of the fs laser relative to the ns to boost the high harmonic signal [2].

• We will vary the position of the laser focus and the angle of incidence.

• We will vary targets to influence enhancement of individual harmonics.

References

[1] H. C. Kapteyn, M. M. Murnane, and I. P. Christov, Phys.Today **58**, No. 03, 39 (2005).
[2] Ganeev, R. A., Singhal, H., Naik, A.P., *et al*., Phys. Rev. A **74**, 063824 (2006).

Acknowledgements: This work was supported by Science Foundation Ireland under grant number 08/RFP/PH41180